بسم الله الرحمن الرحيم

Good
Morning

DIAGNOSIS IN ENDODONTICS

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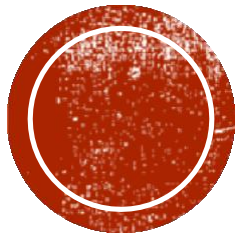
Lecturer of Endodontics

ILOS:

- a2. List the different endodontic diagnostic tests.
- b3. Predict the proper diagnostic procedures relevant to each case.
- c2. Assess efficiently the different Endodontic diagnostic tests.
- d1. Appreciate lifelong learning.
- d3. Develop skills for retrieving information for research.
- d4. Manage time properly.



DEFINITION:

- 1) The art of distinguishing or identifying disease.

- 2) Elimination of the nature of a disease condition, by careful investigation of its symptoms and history. [Compact Oxford English Dictionary]

- “To reach a correct diagnosis; clear dental and medical history has to be taken, as well as performing appropriate diagnostic tests”.

Walton and Torabinejad

A SUCCESSFUL DIAGNOSTICIAN SHOULD HAVE:

- 1) Knowledge: to know, distinguish and decide when & where to refer the cases.
- 2) Interest: a natural characteristic to discover disease.
- 3) Intuition: to suspect the unusual (sixth sense).
- 4) Curiosity: good detective.
- 5) Patience: give enough time to approach correct diagnosis.
- 6) *Sense: use all the physical tools: ears to hear, eyes to see, hands to palpate and nose to smell.
- 7) Equipments.

ROUTES OF DIAGNOSIS

I. Case history.
II. Clinical examination.
III. Laboratory investigations.

I) CASE HISTORY:

- A) Personal Data: name, age, sex, address, telephone number, occupation, marital status.
- B) Medical History: recording the diseases and current medications of the patient.
- i) some medical conditions need precautions, others need consultation and some may need hospitalization.

Medical condition	Precaution taken
History of infective endocarditis	Regarded as special high-risk group. Antibiotic coverage is required.
Congenital cardiac abnormality	Consider antibiotic coverage.
Rheumatic fever	May consider antibiotic coverage.
Artificial heart valves, prosthesis for total replacement of a joint	Consider antibiotic coverage.
Cardiovascular disease	GMP* to advise alteration of drug therapy. Non-surgical endodontics preferred. Analgesics to reduce postoperative pain. Stress-reduction protocol. Short and morning appointments.
Hypertension	Consult physician. Non-surgical endodontics preferred. Analgesics to reduce post-operative pain. Stress-reduction protocol. Short and morning appointments. Adjustment of anticoagulant therapy before endo-surgery.
Blood disease (Hemophilia)	Consultation (adjustment of bleeding & clotting time). Root canal treatment preferred to extraction. Hospitalization if surgery required. Local haemostatic agents (absorbable collagen/ Gelfoam). Avoid bleeding by LA** injection by using shorter needles. Sequential pulp extirpation; repeated formocresol application till complete removal of fixed tissues. Avoid gingival lacerations by clamp placement; make facial & lingual notches on tooth.
Diabetes Mellitus	Blood glucose level adjustment especially before surgery. Delayed healing can be expected. Antibiotic coverage if surgery intended or infection present. GMP to advise alteration of drug therapy. Avoid epinephrine as vasoconstrictor in local anesthesia (breaks down glycogen to glucose). No aspirin prescribed as it enhances insulin action (insulin shock). Stress-reduction protocol. Short, morning and after meal appointments. Candy bar for hypoglycaemia.
Hepatitis	An infectious disease, operator is at risk of cross infection via contaminated instruments. Bleeding expected due to Vit. K deficiency. Avoid prescribing drugs detoxified in the liver. GMP to check if the patient is a carrier (Lab investigation). Precautions: 1) Vaccination for all dental personnel. 2) Rubber gloves (even double gloves), mask, eye shields, full length gowns. 3) Low speed instruments. 4) Dispose instruments after use e.g. files, burs, etc. 5) Disinfect operating area with 2% glutaraldehyde solution and place all used instruments in the solution for 1 hr before sterilization. 6) Treat at the end of the day.
Immune-suppressed states	Antibiotic coverage if infection is present.
Patients on corticosteroid or drugs to maintain organ transplants	Possible corticosteroid supplements by GMP during and after endodontic treatment.
Radiotherapy for malignant disease	Any extraction is necessary to be carried out before radiotherapy to prevent osteo-radionecrosis. Root canal treatment is preferred to extraction after therapy.

* *GMP= general medical practitioner.* ** LA = *Local Anasthesia*

I) CASE HISTORY:

- ii) drugs regularly taken should be listed as some can cause oral manifestations*, some may cause drug interaction with others.
- iii) also allergy to certain drugs should be recorded.

I) CASE HISTORY:

- C) Past dental history:

i. degree of sophistication of the patient.

ii. patient's interest in keeping his dentition in healthy condition.

iii. patient's past dental experience: allergy to local anaesthesia or rubber dam material, excessive bleeding after extractions, previous trauma or recurrent abscess.

I) CASE HISTORY:

- D) Present dental history:

i) Chief complaint should be recorded in patient's own words.

ii) Careful questioning and subjective symptoms recorded to evaluate the patient's problem*.

N.B: Four words in patient's complaint are significant in identifying pulp and/or periapical disease*.+

II) CLINICAL EXAMINATION:

- Extraoral examination
  - Vital signs
  - Visual inspection & palpation
- **INTRAORAL EXAMINATION**
  - General examination
  - Examination of the questioned tooth

II) CLINICAL EXAMINATION:

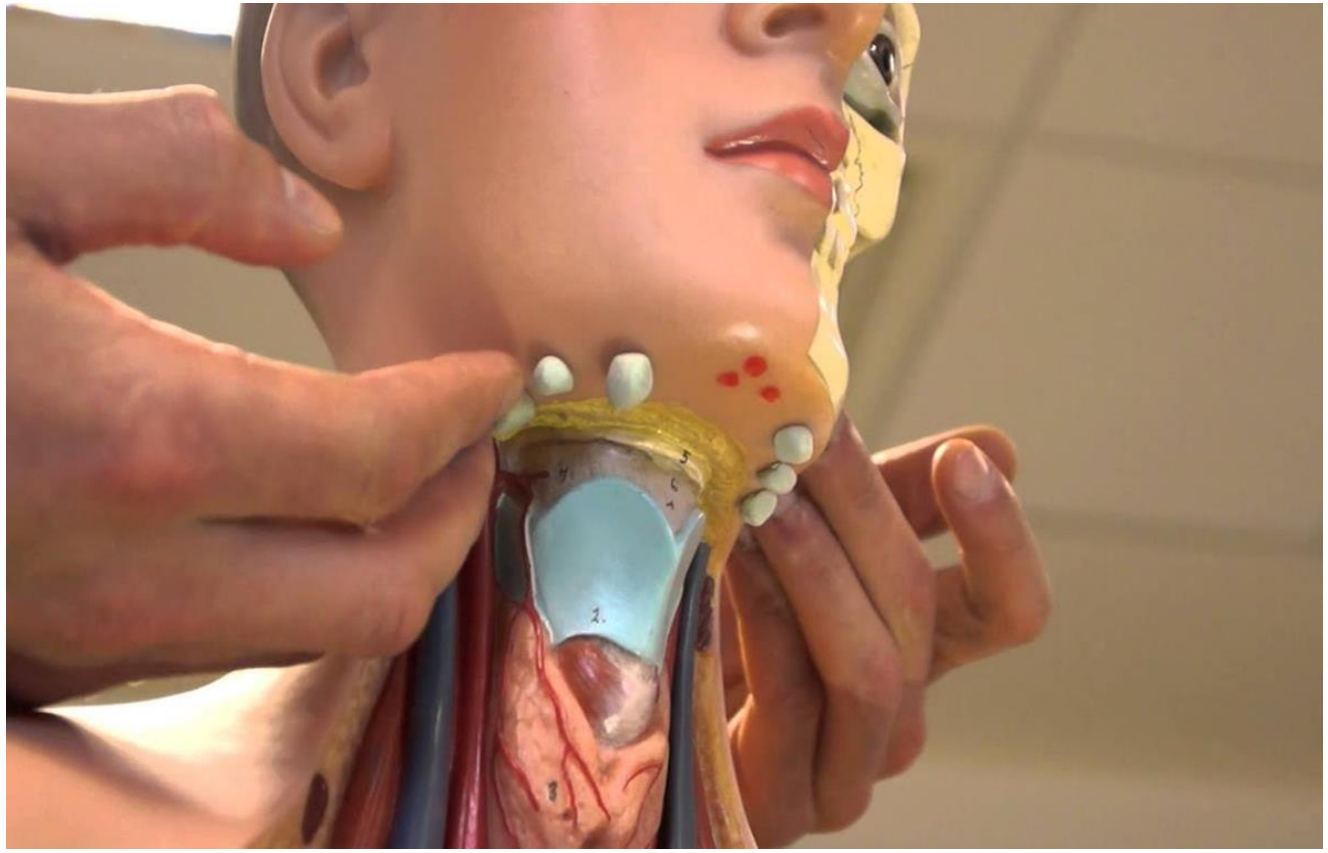
A] EXTRAORAL EXAMINATION:

- **1) Vital signs:** breathlessness, color change, altered gait or unusual body movement.
- Blood pressure: < 60 yrs →120/80 mm Hg, > 60 yrs → 140/90 mmHg.
- Pulse rate: 60-100/ min.
- Respiration Rate: 16-18/ min.
- Temperature: 37oC or 98.6 oF.
- Cancer screen (if needed).

II) CLINICAL EXAMINATION:

A] EXTRAORAL EXAMINATION:

- **2) Visual inspection and palpation:**
- Color of the eye, face or skin.
- Face, lips, neck & TMJ.
- Facial asymmetry, localized swelling or sinus tract.*
- Soft tissue trauma, burns, bruises, abrasions, scars or cuts.
- Lymph node enlargement.*
- Skin disease.



II) CLINICAL EXAMINATION:

B] INTRAORAL EXAMINATION:

- 1) General examination:

Visual and bidigital palpation to examine signs in the oral cavity.

- 2) Examination of the tooth in question:

a) Visual test: discoloured tooth, deep carious lesion, defective restoration, intraoral swelling, fistula…etc.,

II) CLINICAL EXAMINATION:

b) Percussion test:

- Reveals the condition and spread of inflammation in the periodontal tissues.
- Technique: Gentle tapping with the handle of the mirror vertically on the occlusal or the incisal surface, and horizontally.

II) CLINICAL EXAMINATION:

b) Percussion test:

- Positive response could be due to:

i) apical periodontitis: extension of pulp inflammation, traumatic occlusion, over-instrumentation.

ii) acute periapical abscess.

iii) sinusitis.

iv) Premature contact of high restoration.

v) Cracked tooth.

II) CLINICAL EXAMINATION:

c) P

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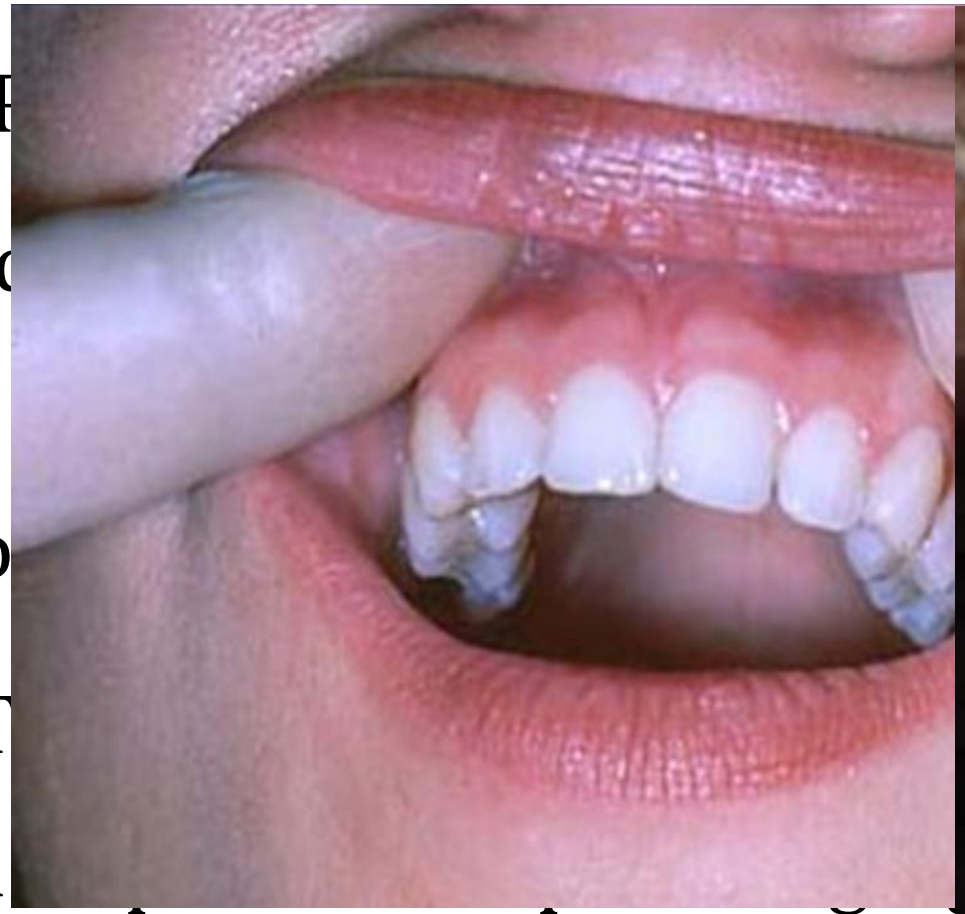
  bone using gloved index finger.



II) CLINICAL EXAMINATION:

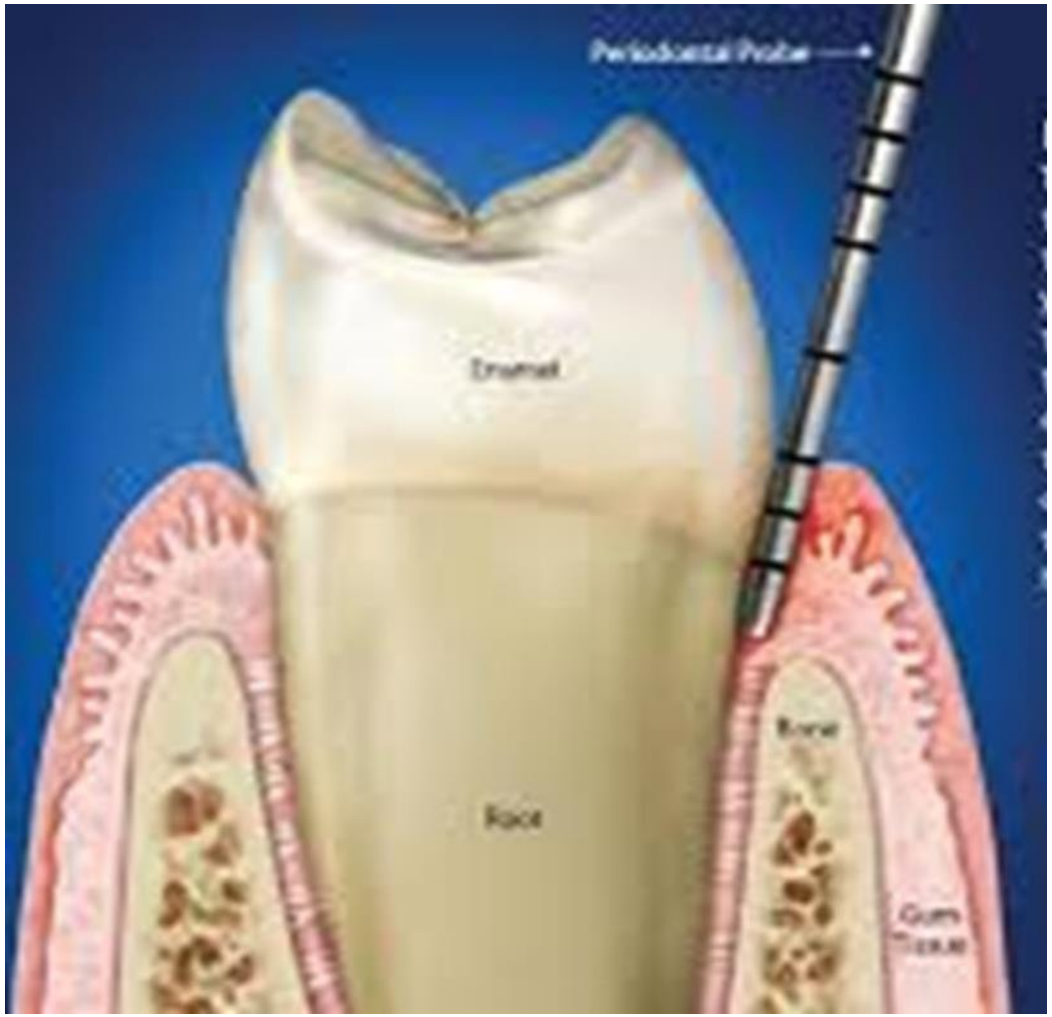
- c) Palpation test:

N.B: Examination is most effective when it is performed bilaterally.

II) CLINICAL EXAMINATION:

d) Periodontal evaluation (probing):

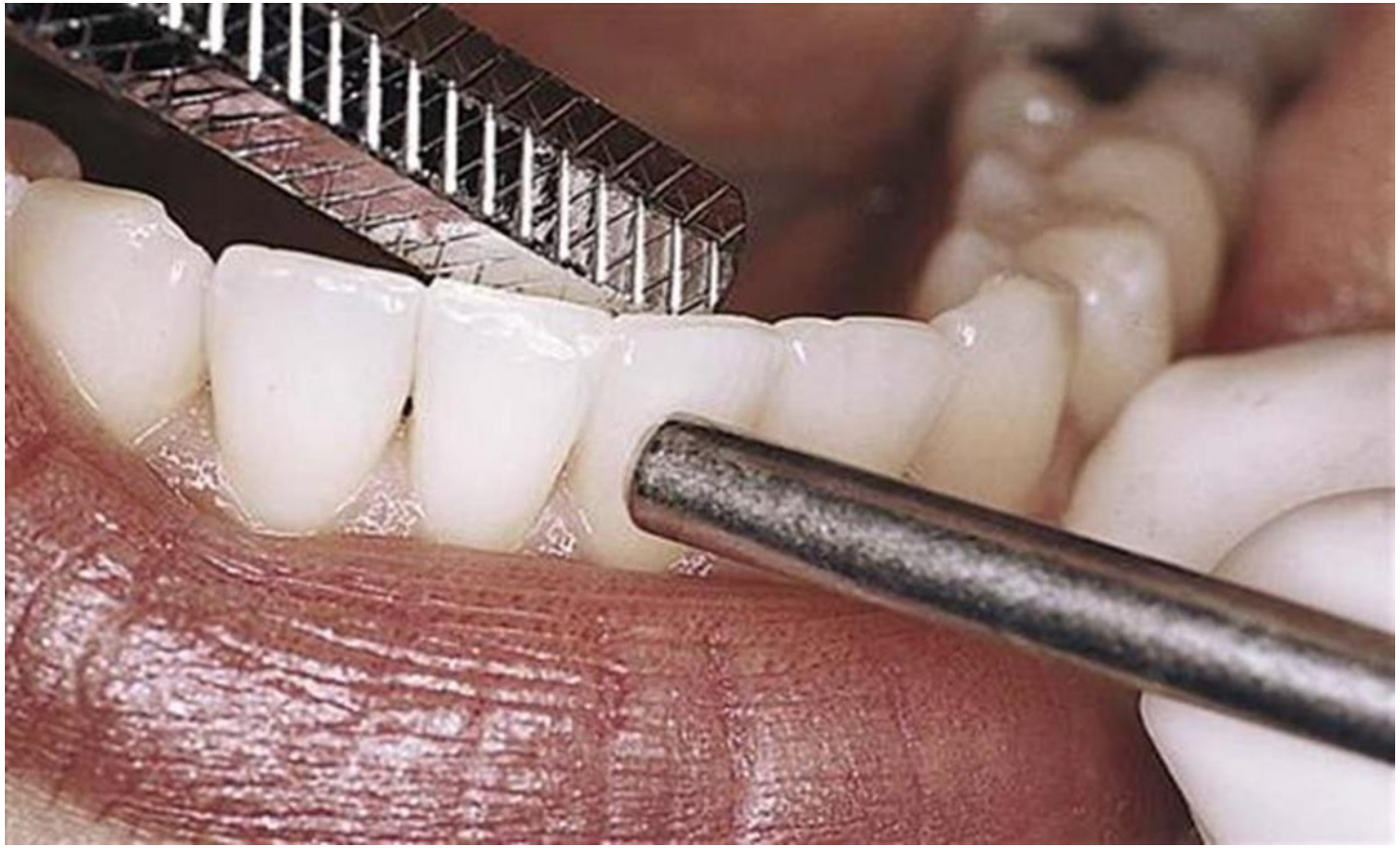
- Careful evaluation of the periodontal support & attachment level of teeth **MUST** be included in any dental examination due to communication between the pulp & periodontium.
- Technique: Probing the gingival crevice all around the tooth in 4-6 points to test pocket depth, plaque/ calculus, gingival or sulcular bleeding/ drainage & furcal involvement in multi-rooted teeth.


Periodontal Probe
Enamel
Root
Bone
Gum

II) CLINICAL EXAMINATION:

e) Mobility test:

- Detects integrity of the alveolar attachment & gives an idea about the periodontal status of the tooth.*
- Technique: using the handles of 2 instruments (one placed buccaly and the other lingually), pressure is applied in a bucco-lingual direction.*



II) CLINICAL EXAMINATION:

e) Mobility test:

- Degree of mobility:

➢ Grade I: < 1mm → physiologic, not felt neither by the patient nor the dentist.

➢ Grade II: 1mm, felt by the dentist only may require splinting.

➢ Grade III: > 1mm, felt by the dentist & the patient requiring extraction.

II) CLINICAL EXAMINATION:

C] DIAGNOSTIC AIDS:

1) Radiograph: one of the most important & valuable tools in establishing diagnosis, however, it can't be relied on as it has many limitations.

II) CLINICAL EXAMINATION:

- ***Limitations of x-rays:***

- 2D image for a 3D object.
- Too long or too short image (angle of the x-ray cone)→ no exact W.L can be obtained.
- can't identify diseases.
- Too dark or too light image can't determine the exact bone density.

II) CLINICAL EXAMINATION:

- ***Limitations of x-rays:***

- In double curved root, difficult to determine W.L→ needs radiologist.
- Pulp condition & soft tissue changes can't be detected.
- Lesions of medullar bone go undetected until resorption is considerable & eroded a portion of the cortical plate.
- Superimposition → shift technique is recommended.

II) CLINICAL EXAMINATION:

- *i) Preoperative radiograph:* find out if the tooth is indicated for endodontic treatment & extrapolate a number of data.* presence of an extra root or root canal can be suspected if the outline of the root is unclear or has unusual contour*.
- *ii) During operation:* tooth length determination, to detect any obstruction during work (ledge), detect perforation, instrument fracture & its level and verification of the master cone.

II) CLINICAL EXAMINATION:

- *iii) Postoperative radiograph:* post-treatment evaluation & follow-up.

- Common radiographic techniques:

1) Bisecting technique.

2) Paralleling technique.

3) Shift technique (Clark's rule or Buccal Object rule)*.

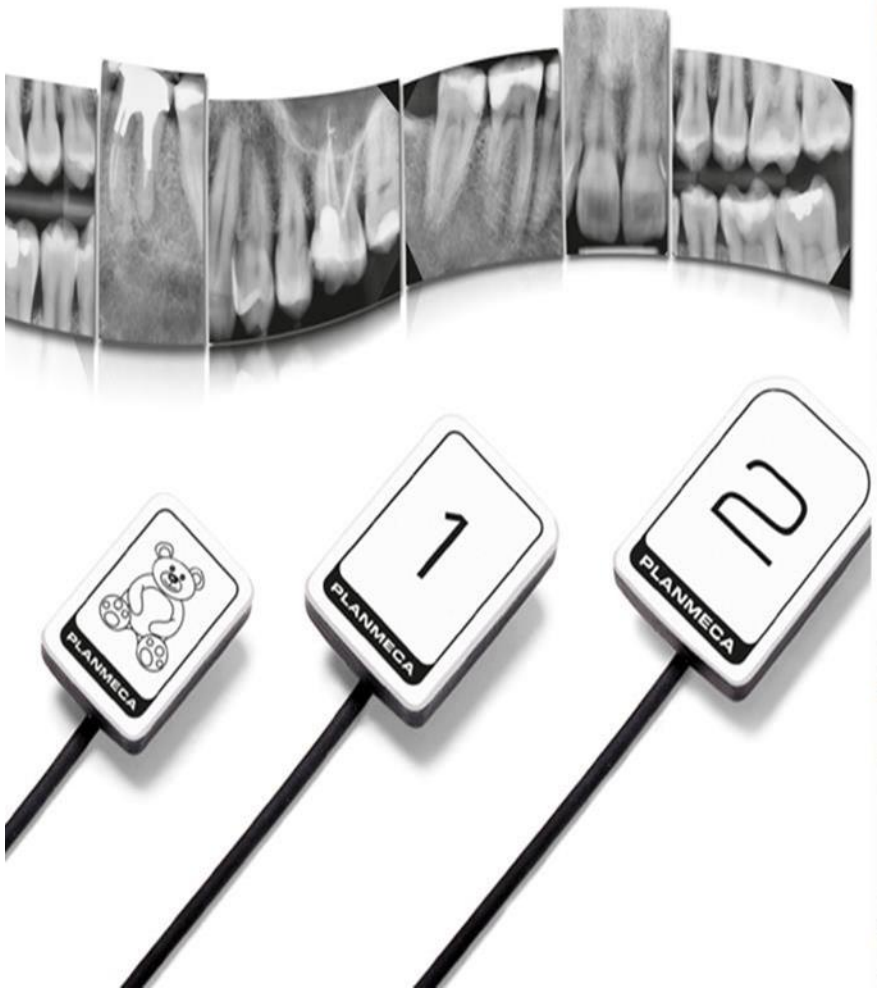
II) CLINICAL EXAMINATION:

- *Importance of shift technique in endodontics:*

- Tooth length determination in multi-rooted teeth.
- Moves the anatomical landmarks →improving visualization of obscured objects.
- Distinguish between landmarks & radiolucent areas associated with root pathosis.
- Distinguish between internal & external resorption.

II) CLINICAL EXAMINATION:

- ***Recent advances in radiography:***
- I) Digital radiography (e.g: Radio-Visio-Graphy RVG): depends on programmed computerized receiver that processes signals from intra-oral sensor stimulated by x-ray from a standard machine.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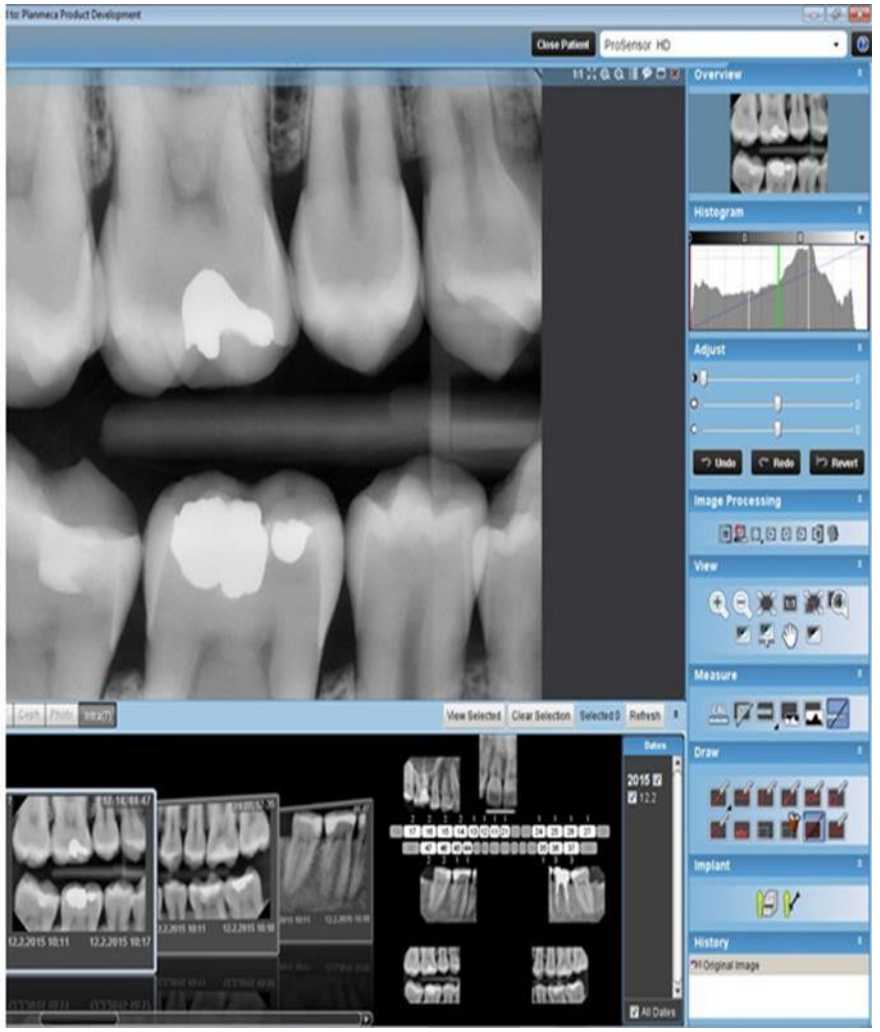
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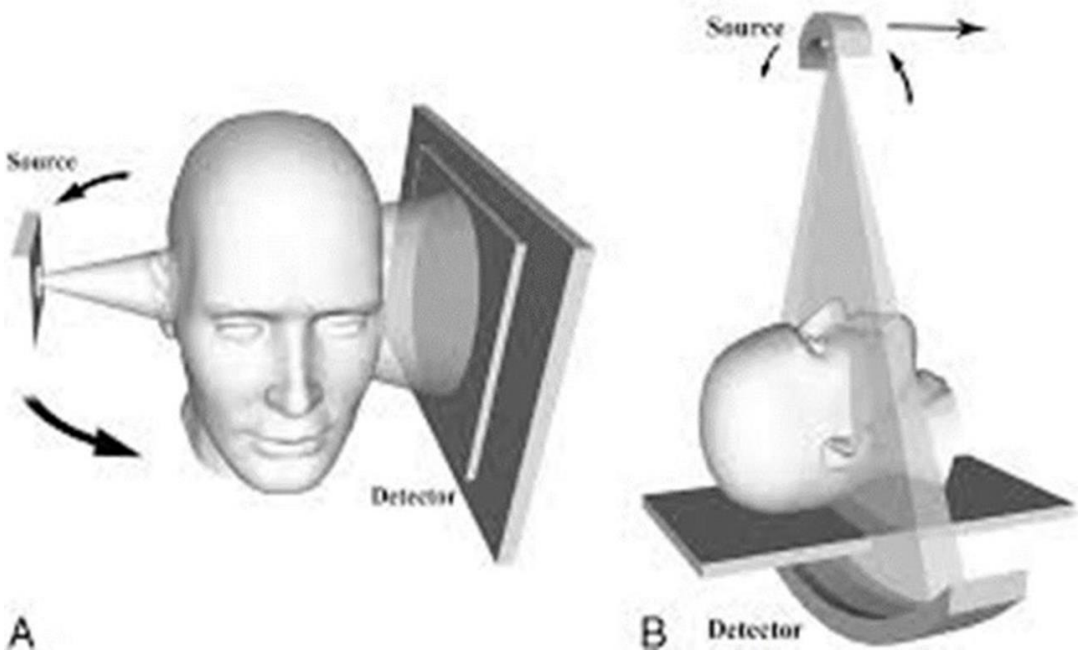
II) CLINICAL EXAMINATION:

- *Advantages of digital radiography:*
  - Radiographic image is obtained immediately.
  - Elimination of x-ray film processing.
  - Reduced radiation exposure by 50-90%.
- *Disadvantages:*
  - Potential reduction in image quality.
  - High cost.

II) CLINICAL EXAMINATION:

- II) Cone-Beam Computed Tomography (CBCT): machines are similar to dental panoramic device, whereby the patient is exposed to a cone-shaped radiographic beam directed to the target area with a reciprocating capturing sensor on the opposite side. The resulting information is digitally reconstructed, whereby the clinician can interpret slices of tissues in several planes in a 3D manner.


Source
Detector
A
Source
B
Detector

II) CLINICAL EXAMINATION:

C] DIAGNOSTIC AIDS:

- 2) Pulp sensitivity tests: based on stimulating the pulp sensory nerve fibers either by thermal or electrical stimulus.
- There are three types of pulp nerves: large, intermediate & small; the larger the diameter the faster the conduction of the stimulus.

II) CLINICAL EXAMINATION:

- a) Larger myelinated nerves (A-fibers):

➢ A-alpha (Aα): carry touch & pressure.

➢ A-beta (Aβ): carry proprioception & vibration.

➢ A- gamma (Aɣ): Mechanoreceptors.

➢ A-delta (Aδ): carry pain & temperature.

II) CLINICAL EXAMINATION:

- b) Intermediate (Efferent) nerve fibers: B fibers.
- c) Small unmyelinated C fibers: transmit pain & temperature.

	A-Delta fibers	C- fibers
Diameter	2-5 µm	0.2-1.5 µm
Velocity	3-30 m/s	0.5-2 m/s
Myelin sheath	Myelinated	Unmyelinated
Terminals	Dentinoblast & sub-odontoblastic layer	Near blood vessels
Pain characteristics	Sharp, pricking, less bearable	Throbbing, aching but bearable
Stimulus threshold	Low threshold	High threshold
Hypoxia	Short survival (first to be degenerated) in presence of pulp necrosis	Longer survival (last to be degenerated) in presence of pulp necrosis.

II) CLINICAL EXAMINATION:

C] DIAGNOSTIC AIDS:

- 2) *__**Pulp sensitivity tests:**__ based on stimulating the pulp sensory nerve fibers either by thermal or electrical stimulus.

- Pulp sensitivity tests are (according to type of stimulus):
- i) Thermal tests (hot or cold stimulus).
- ii) Electric pulp test (Electric pulp tester).

II) CLINICAL EXAMINATION:

- ***Before proceeding in any sensitivity test:***

a. The process should be explained to the patient.

b. Demonstrate the test on several teeth or the contra-lateral tooth (**control tooth***) for comparison.

c. The clinician should agree on the signals that the patient can indicate the feeling of pain.

d. Tooth should be isolated and dried.

e. Stimulus should be applied on the middle or incisal thirds of the labial surface or on the occlusal surface.

II) CLINICAL EXAMINATION:

- i) Thermal tests: valuable diagnostic aids in certain pulp inflammation types, where pain may be relieved by applying cold or warm stimuli.
- N.B: Thermal tolerance zone of dentin (where it isolates any change in temperature) is within a range from 20oC to 50oC.

II) CLINICAL EXAMINATION:

- Cold test: reliable in differentiation between reversible & irreversible pulpitis than in differentiation between viable & necrotic pulp.

- Cold test can be made using:

i. Air blast.

ii. Cold water bath.

iii. Ice stick (seldom used).

iv. Ethyl chloride (-53oF).

v. Flori-methane sprays (-21oF).

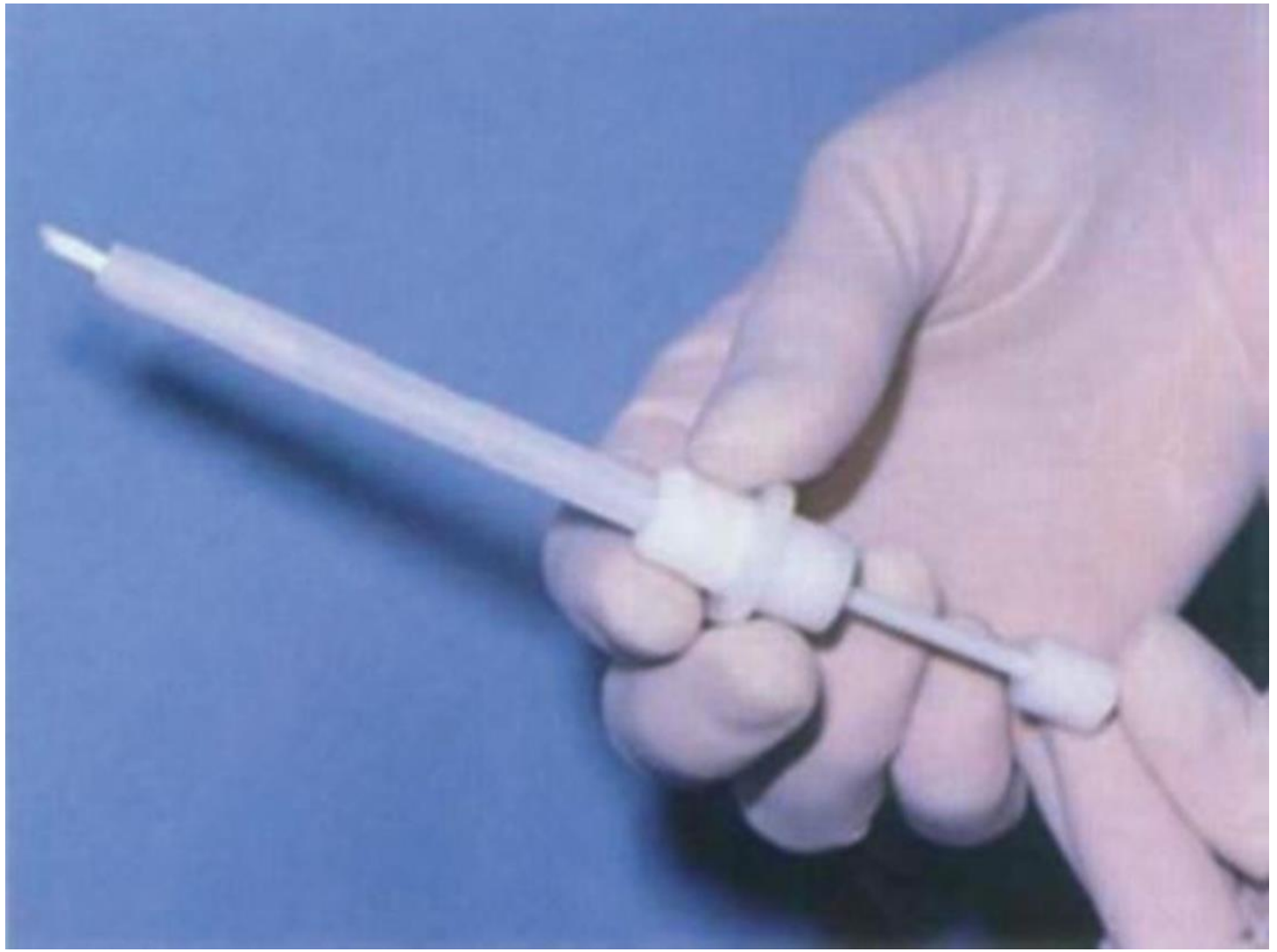
vi. Carbon dioxide (CO2) dry stick*.

COLD WATER BATH

ICE STICK

ETHYL CHLORIDE SPRAY

CARBON DIOXIDE DRY STICK



II) CLINICAL EXAMINATION:

- Hot test: reliable to differentiate between vital & necrotic pulp.
- Can be performed using:

i. Gutta-percha stopping.

ii. Rotating dry prophy cup.

iii. Hot water bath.

iv. Warmed hand instrument.

GUTTA PERCHA STOPPING

ROTATING PROPHY CUP

WARMED HAND INSTRUMENT

II) CLINICAL EXAMINATION:

- Cold or hot water bath, though time consuming, but are the most accurate method because:

a) Water allows the entire crown to be immersed.

b) Cold or hot water bath prevents excessive temperature damage to the tooth.

c) Allows simulation of clinical situation.

II) CLINICAL EXAMINATION:

- ***Possible responses to thermal tests:***

1. Mild-moderate awareness of slight pain that subsides within 1-2 sec after removal of stimulus →normal limits.
2. Strong, momentary pain subsides within 1-2 sec after removal of stimulus → reversible pulpitis.
3. Moderate-strong pain lingering for some secs/mins after removal of stimulus → irreversible pulpitis.
4. No response → necrotic pulp, recent trauma, excessive calcification.

II) CLINICAL EXAMINATION:

- ii) Electric pulp test/tester (EPT):

a. Stimulating pulpal sensory nerve fibers using an electric current.

b. +ve response means there are neural elements in the pulp, however, it doesn't mean the pulp is totally intact.

c. Doesn't provide any information about the vascular supply of the pulp (the true determination of pulp vitality).

II) CLINICAL EXAMINATION:

- N.B: EPT shouldn't be used on patient with cardiac pacemaker → arrhythmia.

- ***Pulp testing can be influenced by:***

1. Age.
2. Mental & emotional stress.
3. Pain threshold level.
4. Condition of the teeth.

II) CLINICAL EXAMINATION:

- ***Pulp testing techniques (types):***

1. *Siemen's EPT*: 2 electrodes, patient holds one in his hand & another on the tooth then the voltage is increased.

- Disadvantage: patient become afraid that the electrode in his hand may give him electric shock so may leave it to fall giving false reading

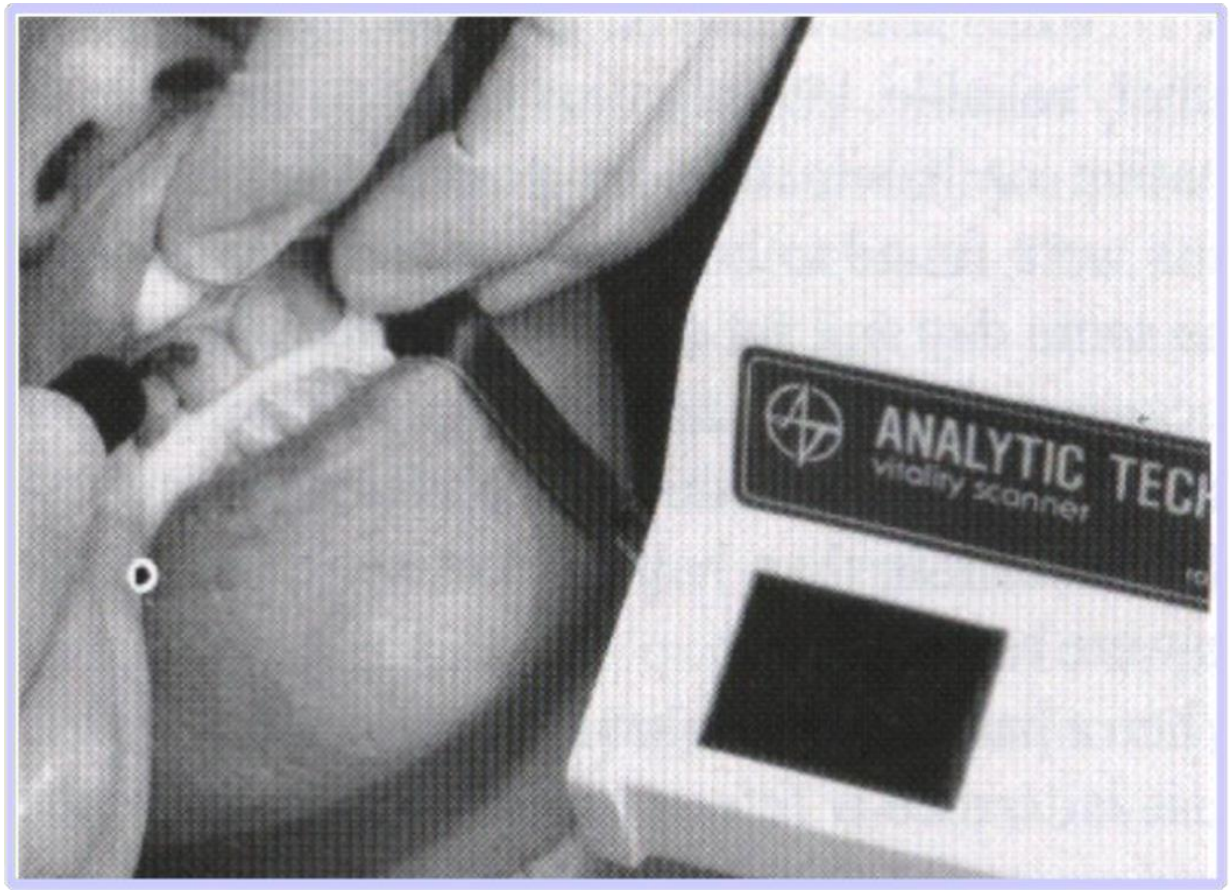
II) CLINICAL EXAMINATION:

- ***Pulp testing techniques (types):***

2. *Monopode EPT*: attached to unit. It is the same as Siemen's EPT but don't have to complete the circuit with the patient.*
3. *Battery-operated EPT:* as the monopode EPT but has its own battery for power.*

- Disadvantage: when the battery is off, no way to know & will give false reading, so the battery must be checked every day.

MONOPODE EPT



BATTERY OPERATED EPT

II) CLINICAL EXAMINATION:

- ***Limitations of EPT:***

1. ***False positive:***

- Multi-rooted teeth with partial necrosis.
- Liquifactive necrosis*.
- Tooth is not dry.
- Gingival response (wrong tip position).
- Electrode placed near large metallic restoration.
- Anxiety.

II) CLINICAL EXAMINATION:

- ***Limitations of EPT:***

2. ***False negative:***

- Recently erupted tooth*.
- Recently traumatized tooth*.
- Diffuse pulp calcification.
- Presence of reparative dentine.
- Inadequate contact between the electrode & enamel.

II) CLINICAL EXAMINATION:

- **Recent advances for vitality testing*:**

1. *LASER DOPPLER FLOWMETRY (LDF)*:

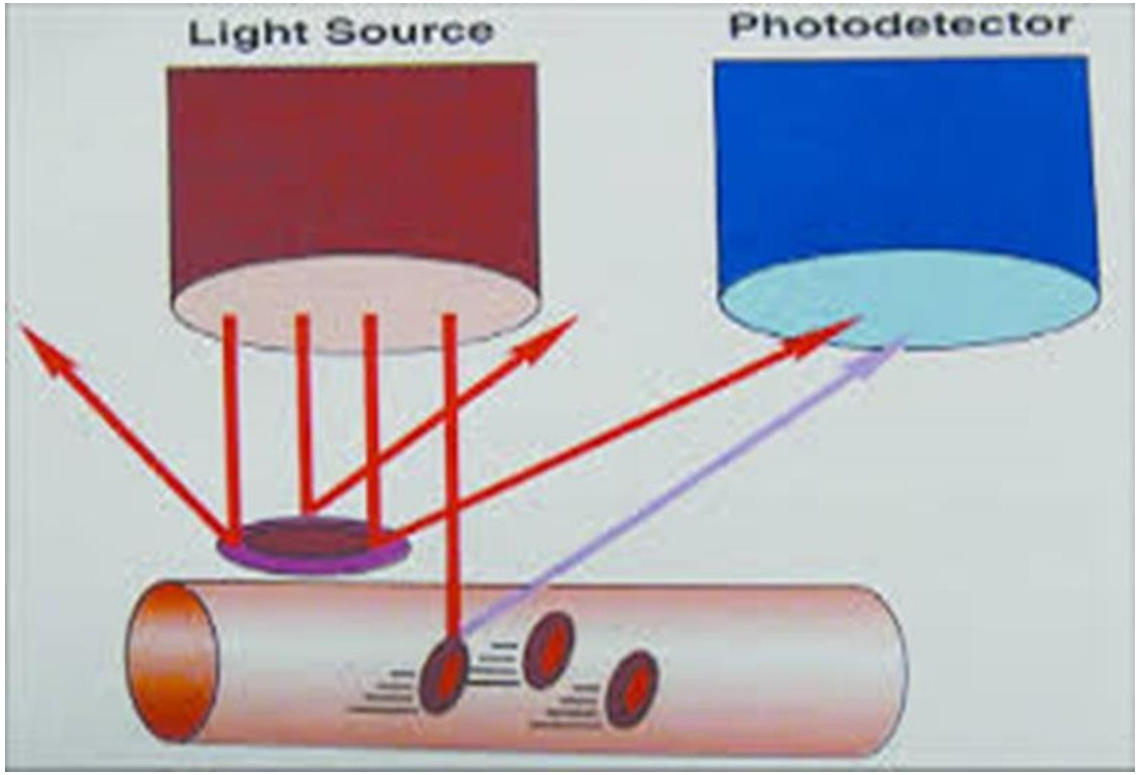
- Measures the blood flow in the pulp tissues.
- Capable of assessing the tooth vitality & re-vascularization of traumatized tooth.

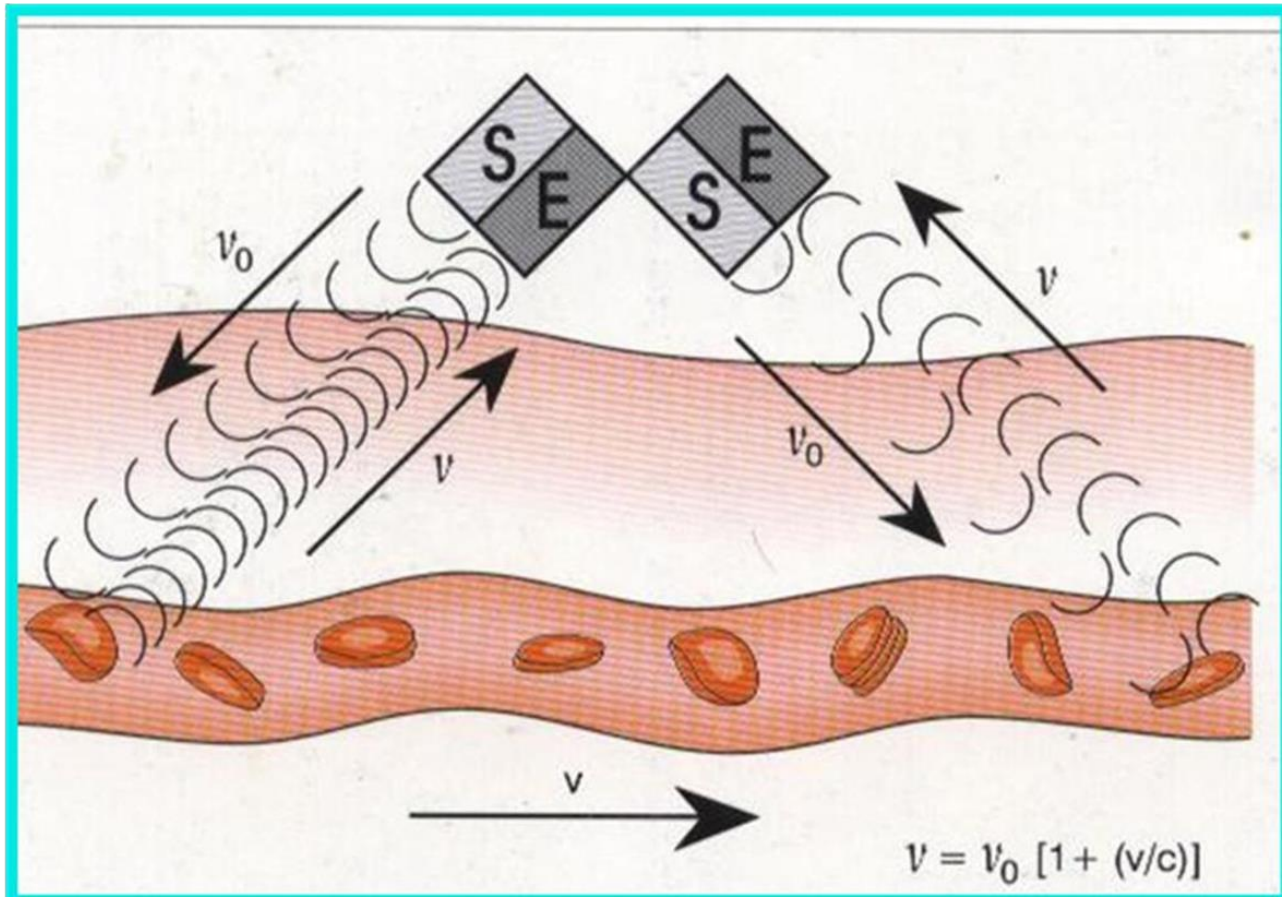
II) CLINICAL EXAMINATION:

- How it works?
- Uses a laser diode emitting light, using a probe placed on the buccal surface of tooth during measuring.
- The probe has 3 fibers: one carrying laser light & the other 2 carrying the back-scattered light to detector.*
- **N.B:** Necrotic teeth give 42.7% lower signals than vital teeth.

(Trans et al.)

LDF MECHANISM OF ACTION





II) CLINICAL EXAMINATION:

- *Advantages:*

i. High accuracy.

ii. Can be used with: anxious patients, mentally-retarded patients, very young patients & unconscious patients.

- *Disadvantages:*

i. Too complex.

ii. Time consuming.

II) CLINICAL EXAMINATION:

- **Recent advances for vitality testing*:**

2. *Pulse Oximetry:*

- Records oxygenation of the blood flow of the pulp.
- Determines the oxygen saturation.

PO DEVICE

II) CLINICAL EXAMINATION:

- *How it works?*
- Light (red & infrared wavelengths) passed from photoelectric diode across the part to be tested & into a receptor.
- Calculating the difference between light emitted & that received to provide pulse rate & oxygen saturation reading.

II) CLINICAL EXAMINATION:

- 2 wavelengths of light emitted from the diode to detect oxygenated haemoglobin (arterial blood) & de-oxygenated haemoglobin (venous blood). The ratio of absorbency of wavelength provides the percentage of oxygenation of the blood.

II) CLINICAL EXAMINATION:

- **N.B:** Both LDF & PO are not applied to routine endodontics due to the fact that pulp circulating system is enclosed within a rigid structure, therefore, it's difficult to measure vitality without extensive hard tissue removal.

II) CLINICAL EXAMINATION:

- **Recent advances for vitality testing:**

3. *Liquid crystal testing:* cholesteric liquid crystals used to show the difference in tooth temperature between vital (hotter) & necrotic (cooler) pulp.

4. *Hughes Probeye camera:* detect temporary changes in temperature as small as 0.1oC, thus measuring pulp vitality.

II) CLINICAL EXAMINATION:

C] DIAGNOSTIC AIDS:

- **3) Selective tests for difficult clinical situations:**
- *A) Occlusal pressure test (Biting test):*
- Pain on biting could be due to: apical periodontitis, periapical abscess, incomplete tooth fracture/cracked tooth.

II) CLINICAL EXAMINATION:

- Simulating the chief complain, the test include wedging force applied by biting on:

i. Orange wood sticks.

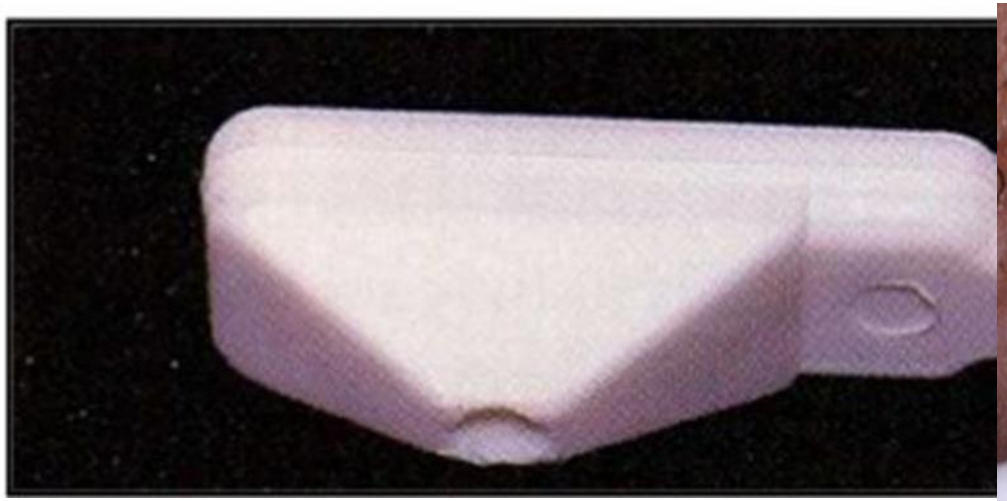
ii. Wet cotton roll*.

iii. Tooth slooth*.

iv. Rubber disc.

ORANGE WOOD STICK

TOOTH SLOTH



II) CLINICAL EXAMINATION:

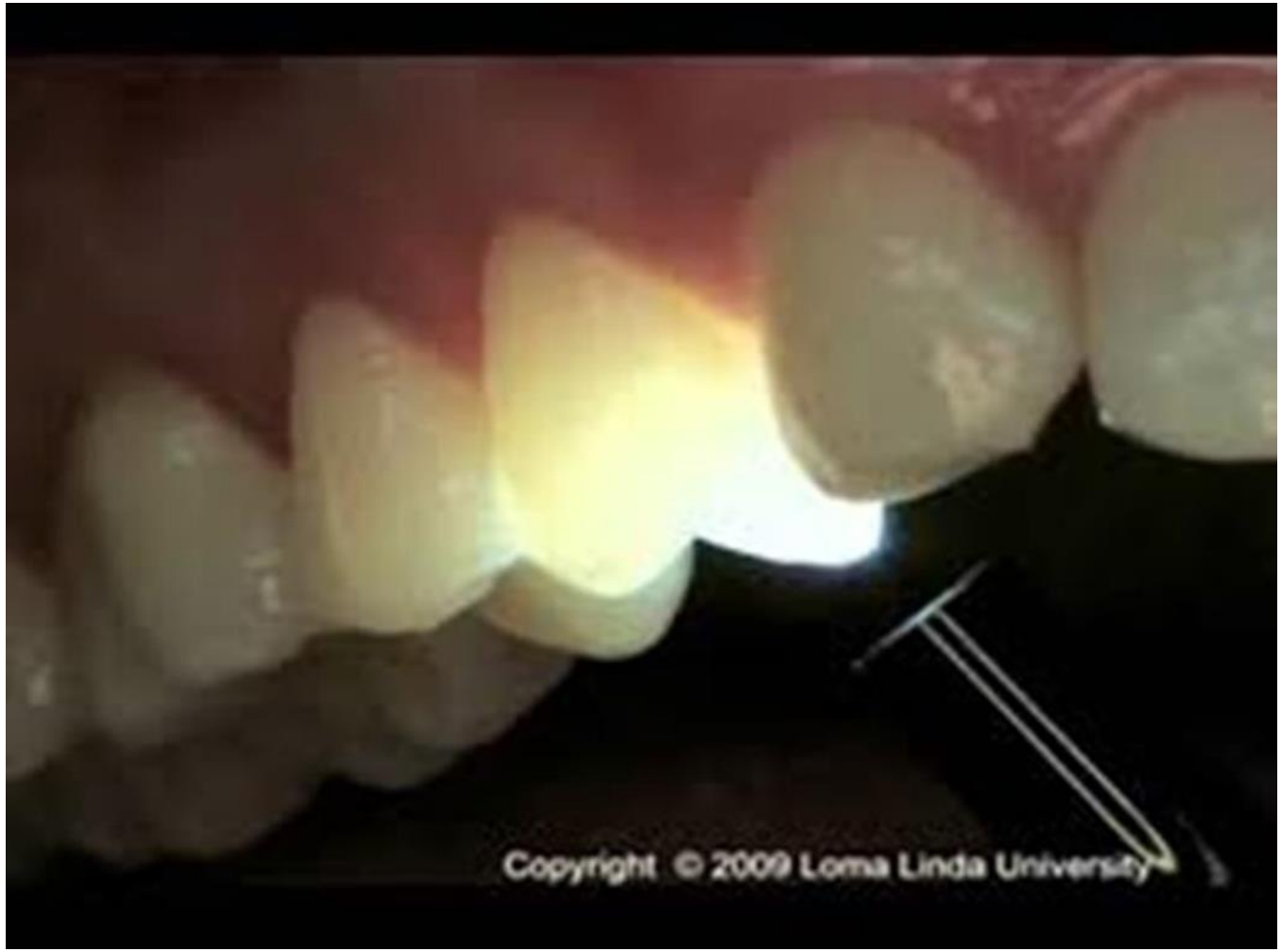
- Dye test: application of stain (methylene blue) before biting on cotton roll/orange wood stick, followed by cleaning with 70% alcohol → fracture lines clearly stained.

DYE BITING TEST

II) CLINICAL EXAMINATION:

- **3) Selective tests for difficult clinical situations:**
- *B) Trans-illumination test:*
- Technique: Fiberoptic light is applied to one surface of the tooth then the tooth is examined from the other side.
- Detect internal resorption, cracks or proximal decay.

TRANSILLUMINATION TEST



II) CLINICAL EXAMINATION:

- **3) Selective tests for difficult clinical situations:**
- *C) Anaesthetic test:*
- Differentiate between maxillary & mandibular pain using infiltration technique.
- Determine the exact tooth responsible for the aching pain achieved by inter-ligamentary injection of the tested tooth with 0.2ml of local anaesthesia.

II) CLINICAL EXAMINATION:

- **3) Selective tests for difficult clinical situations:**

- *D) Gutta Percha point tracing with radiograph:*

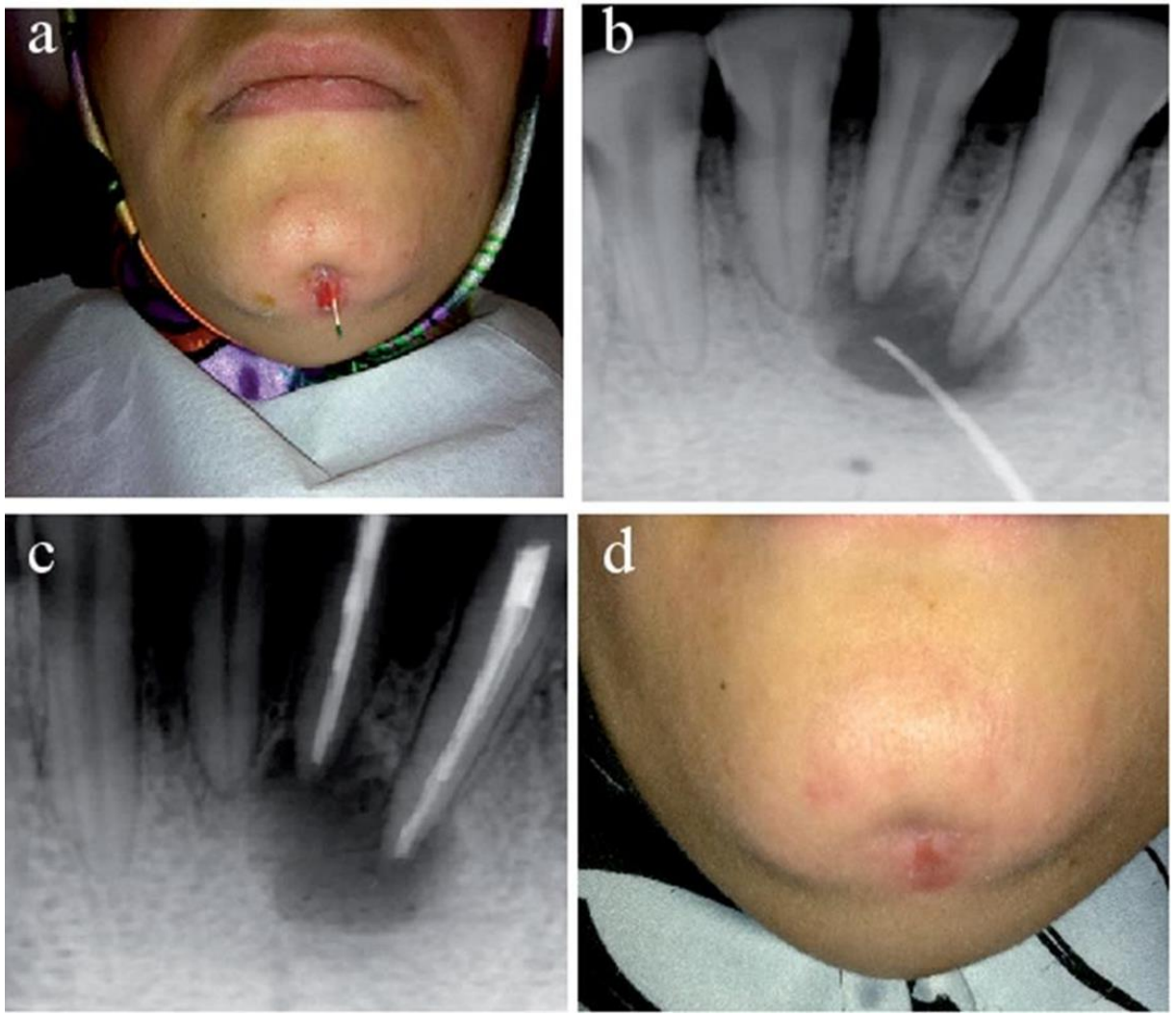
- Technique: gutta percha point is placed through a fistulous tract & take radiograph.

- Used to:

i. relate endodontic lesion to the diseased tooth.

ii. differentiate periodontal lesion from endodontic one.

GUTTA PERCHA POINT TRACING TEST WITH RADIOGRAPH:



II) CLINICAL EXAMINATION:

- **3) Selective tests for difficult clinical situations:**
- D) Cavity test:
- In case of extensive restoration or ceramic crown.
- Technique: a small class I cavity preparation is made with a round bur (without anaesthesia) so that when the bur touches dentine, response is received from vital tooth.

III) LABORATORY INVESTIGATIONS:

- Recommended in case of suspicion.
- Include:

i. blood glucose level.
ii. bleeding time.
iii. clotting time.
iv. kidney function test.
v. liver function test.

RECENT ADVANCES IN ENDODONTIC DIAGNOSIS

DENTAL OPERATING MICROSCOPE (DOM):

- The evolving art & science in endodontics.
- Used in medicine for many years but introduced in the dental field by Dr. Gary Carr in 1992.
- Extremely valuable in endodontic diagnosis as well as during treatment.

MIDDLE MESIAL CANAL

FRACTURE LINE

REFERENCES:

- Endodontics: Principles and practice, 4th edition Mahmoud Torabinejad and Richard E. Walton; 2009
- Pathways of the pulp 12th edition; 2021

Thank You!